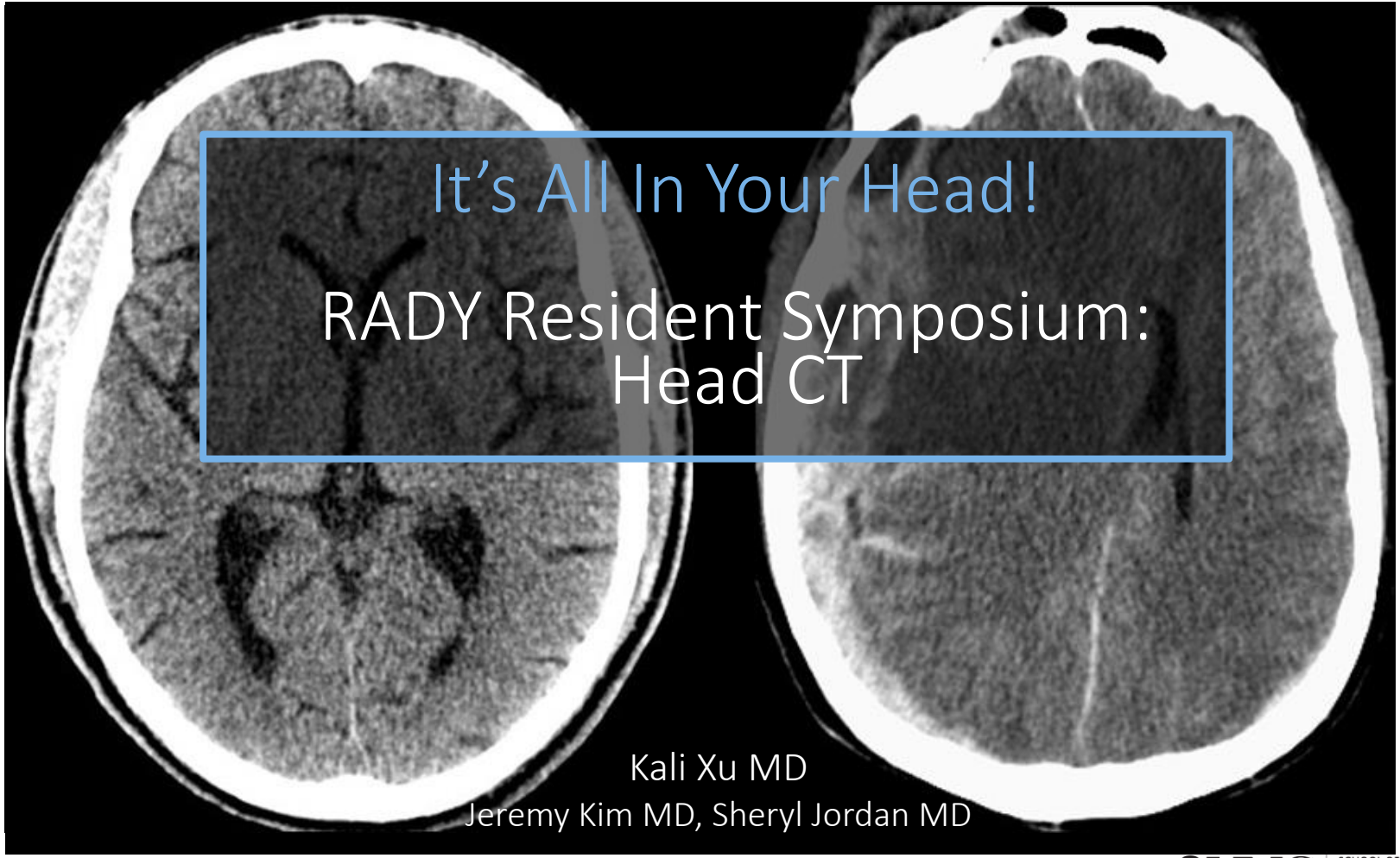

It's All In Your Head!

RADY Resident Symposium: Head CT

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UNC SCHOOL OF MEDICINE Radiology

Learning objectives

By the end of this activity, participants will be able to:

1. Describe the utility of head CTs
2. State head CT anatomy
3. Describe a suggested approach to reviewing head CTs
4. Understand the head CT basics of hydrocephalus and types of intracranial hemorrhage

Module Outline

I. Head CT facts and description of modalities 

II. Anatomy on head CT

III. Approach to head CT interpretation

IV. Common head CT findings

Head CT Facts

- Head CT is usually performed for acute neurologic illness, such as trauma or suspected stroke
  - MRI is typically used for subacute or chronic conditions, or to clarify findings
- Pros: fast, widely available, less susceptible to motion than MRI, no contraindications with implanted devices or foreign bodies
- Cons: significant radiation dose (2 mSv for routine head CT), expensive examination
- Performed with or without IV contrast
  - Risks of contrast problems: allergic reaction, contrast-induced nephropathy

Noncontrast Head CT

- First-line imaging for acute neurologic illness
  - No risk of contrast problems
- Indications: trauma, stroke, hemorrhage, hydrocephalus

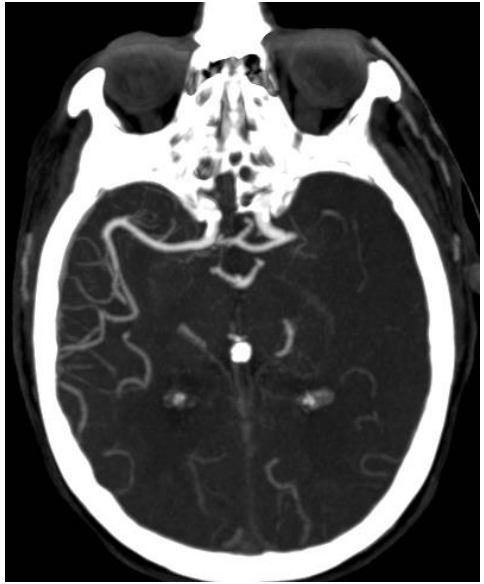
VS.

Contrast Head CT

- Limited indications; MRI usually preferred
- Indications: abscess, infection, cancer (primary or mets)
  - CT with IV contrast only if patient not able to undergo MRI (gadolinium allergy, severe claustrophobia, metallic implant)
  - Positive CT finding may require MRI

CT Angiography (CTA) Head

- IV contrast is administered in arterial phase
  - Looks at vessels
- Indications: aneurysms, AVM, thrombosis, dissection
  - Stroke if planning for intra-arterial thrombectomy



CT Other

CT Orbits

- With or without contrast
- Without contrast: foreign body or trauma
- With contrast: tumor, mass, infection
- Only covers the orbits/includes sinuses

CT Maxillofacial

- With or without contrast
- Without contrast: sinus disease or trauma
- With contrast: tumor, mass, infection
- Includes the whole face including mandible

Tissue Densities and CT Windows

Gray matter: 25-40 HU*
- Contains cell bodies, dendrites, axon terminals
- Cortex & deep gray matter nuclei

White matter: 25-30 HU
- Contains axons (myelinated)
- Subcortical white matter & white matter tracts

CSF: 0-20 HU

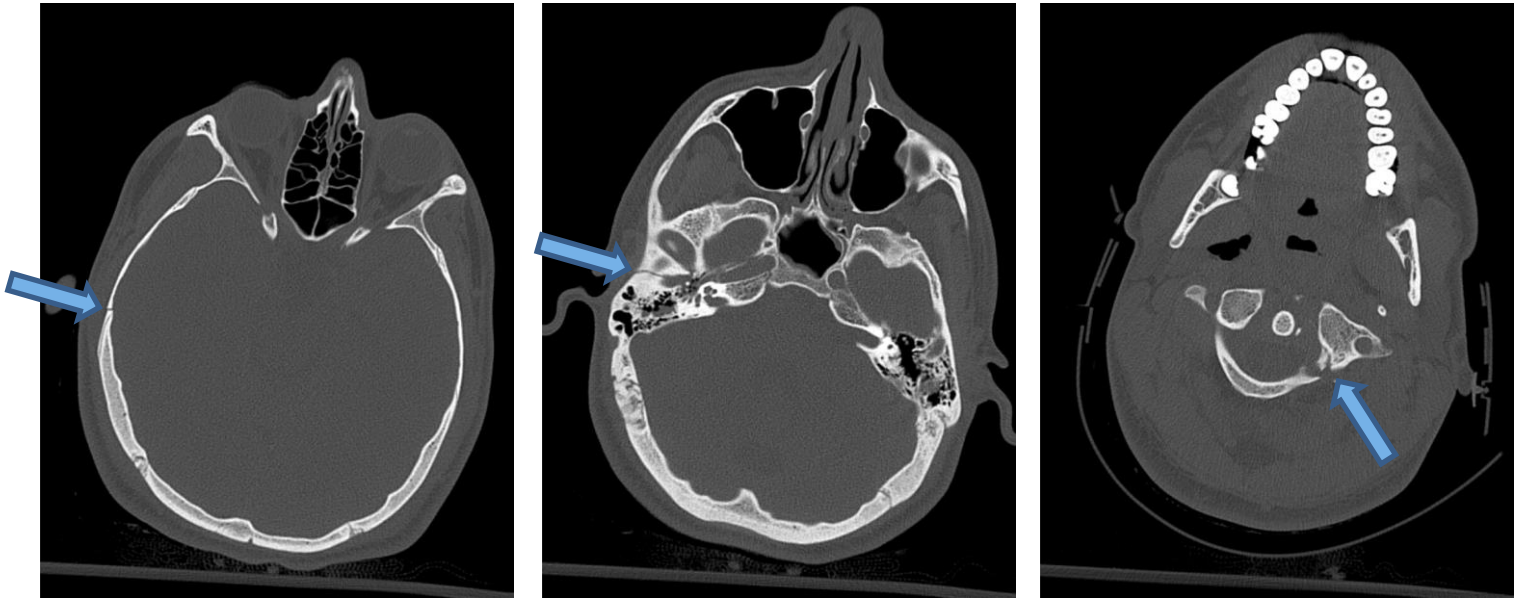
Blood: 40-70 HU (acute)
- Older blood is less dense, becomes more like water

CT Windows:
- Brain
- SDH aka blood
- Stroke
- Bone

*HU=Hounsfield unit, scale measuring radiodensity where the radiodensity of water=0 HU

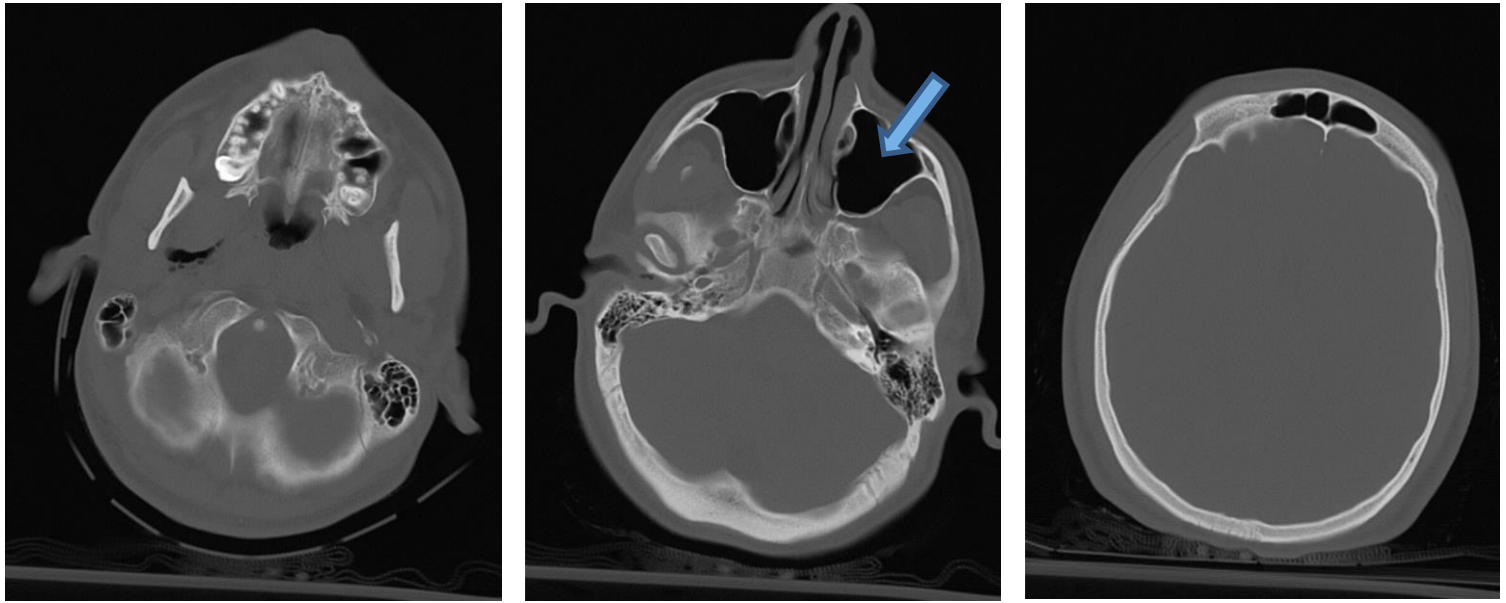
Head CT Examples

Bone window – visualize fractures



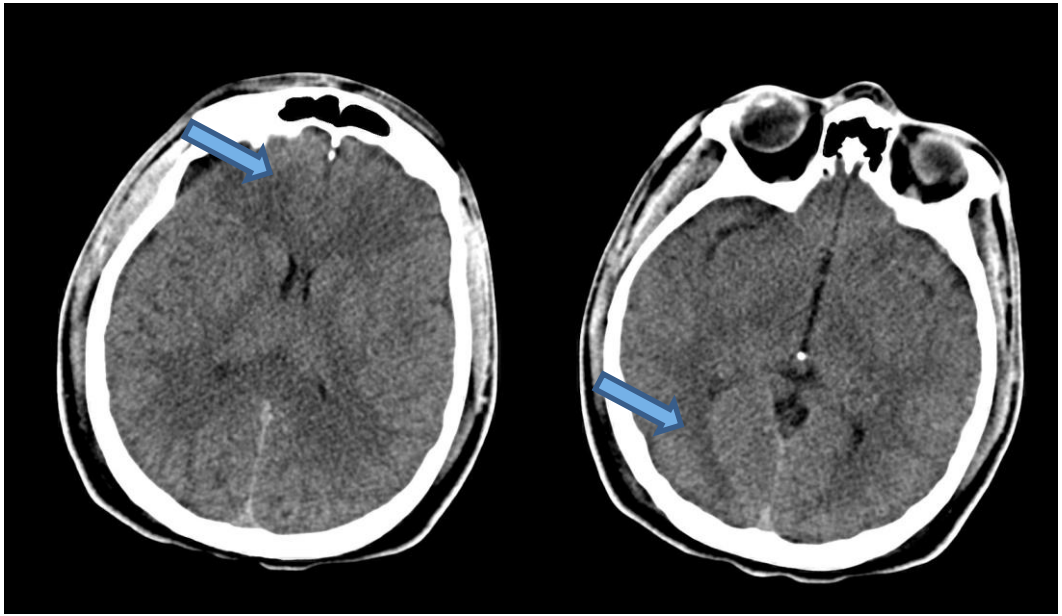
Head CT Examples

Bone window – visualize sinuses



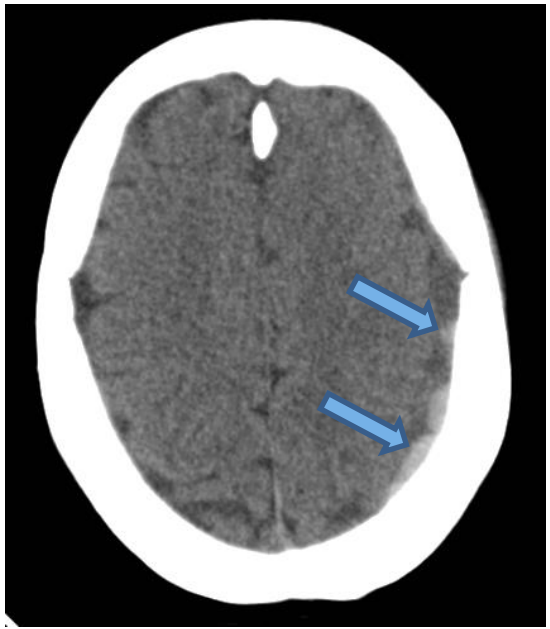
Head CT Examples

Brain window – visualize the gray-white matter interface



Head CT Examples

Subdural (blood)



Stroke (high contrast)

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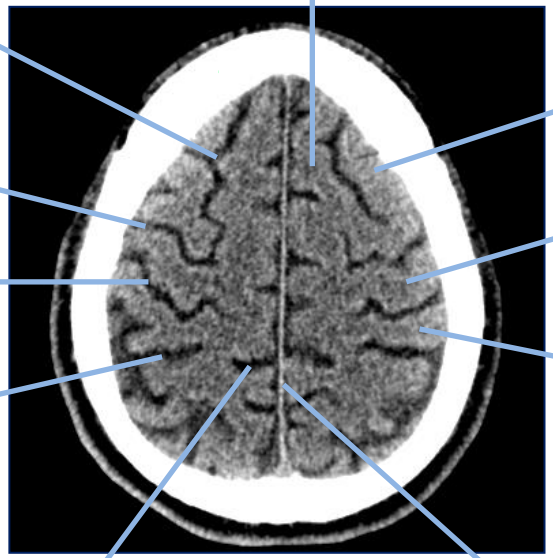
Anatomy: Vertex Level

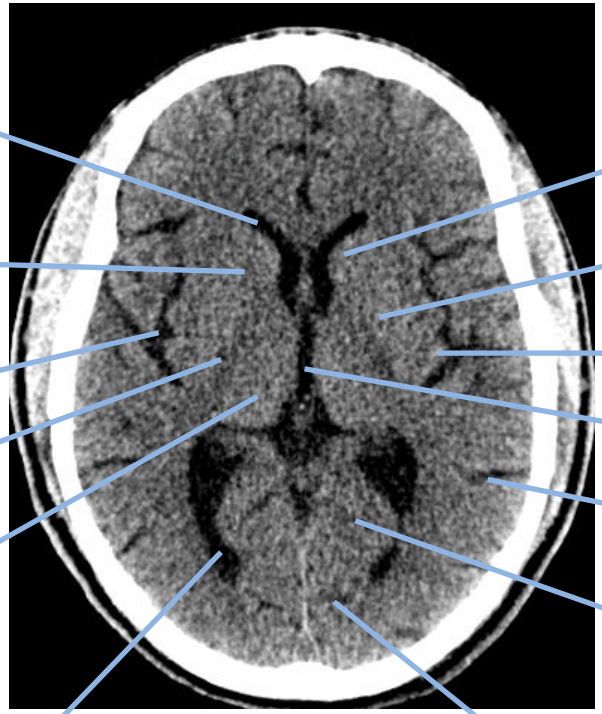
The following views will scroll downward from vertex to foramen magnum.
Note the bolded landmarks!



Anatomy: Lateral Ventricle Level

Note the bolded landmarks!

Anatomy: 3rd Ventricle Level



Lateral ventricle, frontal horn

Internal capsule, anterior limb

Lateral (Sylvian) fissure

Internal capsule, posterior limb

Thalamus

Lateral ventricle, occipital horn

Calcarine sulcus

Parieto-occipital fissure

Superior temporal sulcus

3rd ventricle

Insula

Basal ganglia, lentiform nuclei (GP & putamen)

Caudate, head

Note the bolded landmarks!

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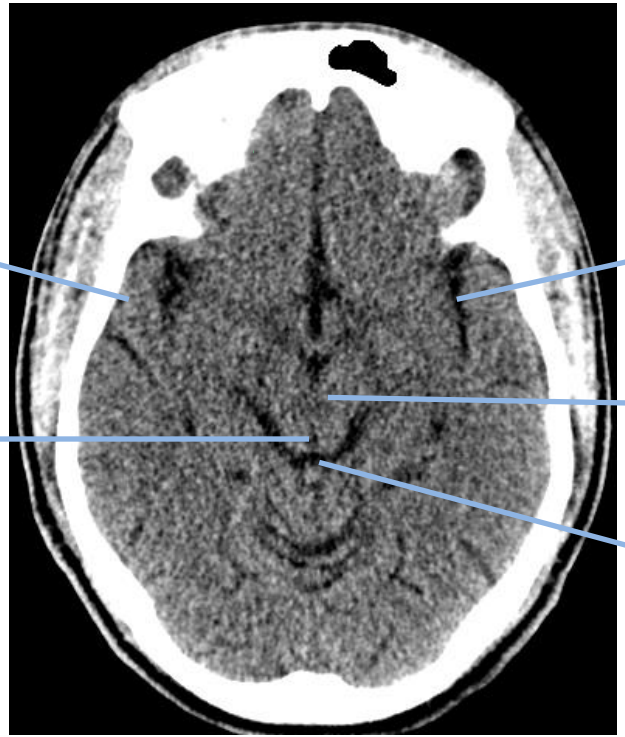
Anatomy: Midbrain Level

Note the bolded landmarks!



Anatomy: Suprasellar Cistern Level

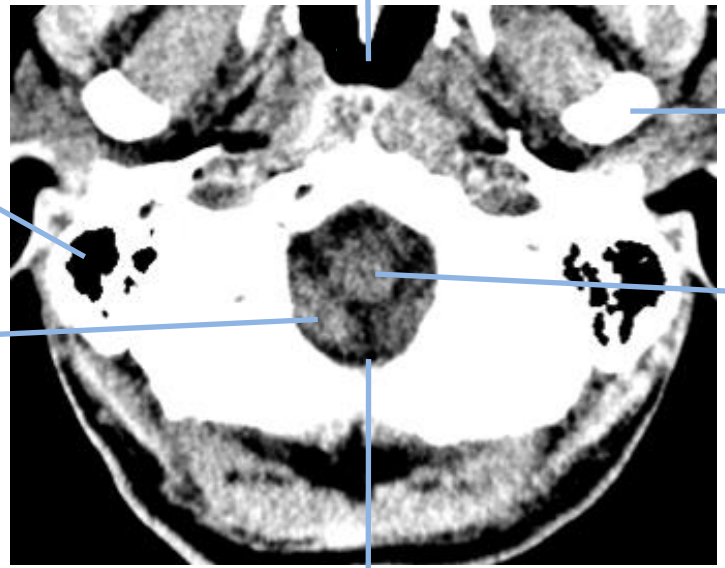
Note the bolded landmarks!

Anatomy: Brachium Pontis Level

Note the bolded landmarks!

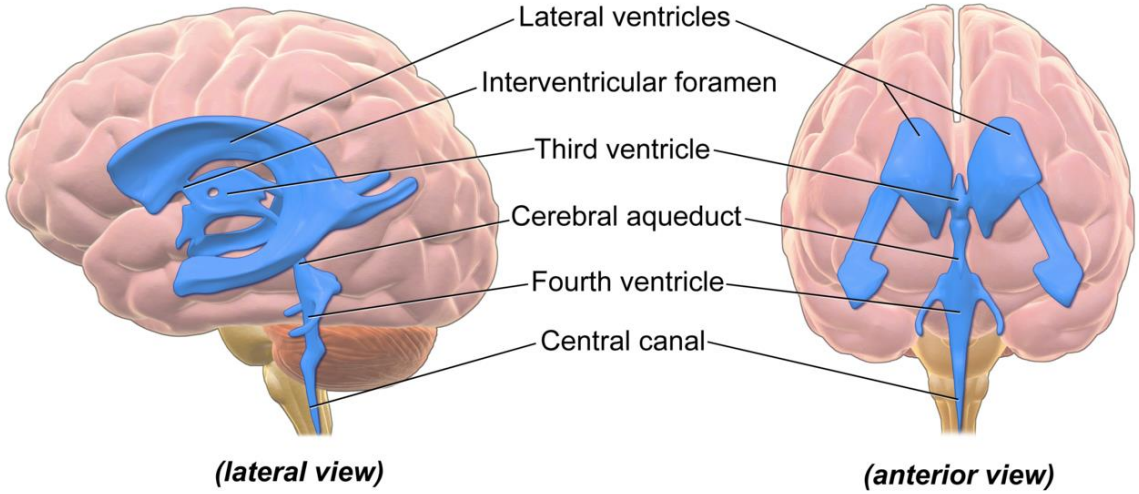
Anatomy: Foramen Magnum Level

Note the bolded landmarks!

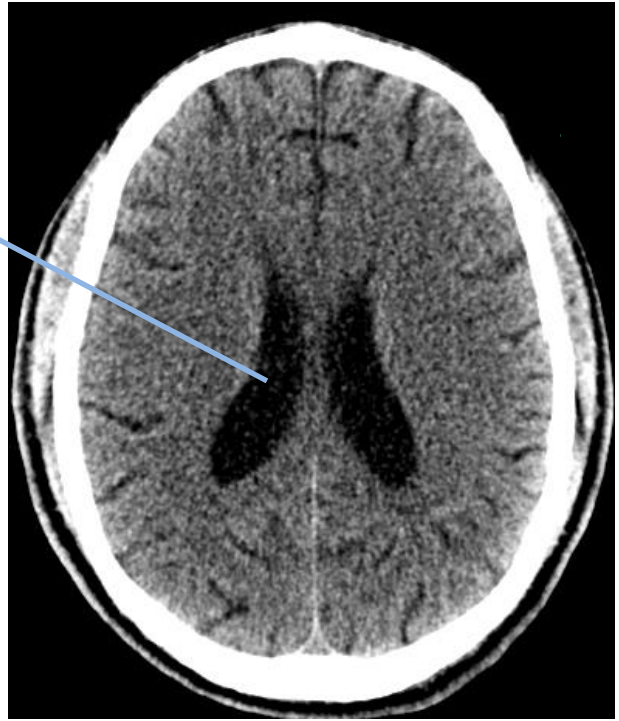


Anatomy: Ventricular System

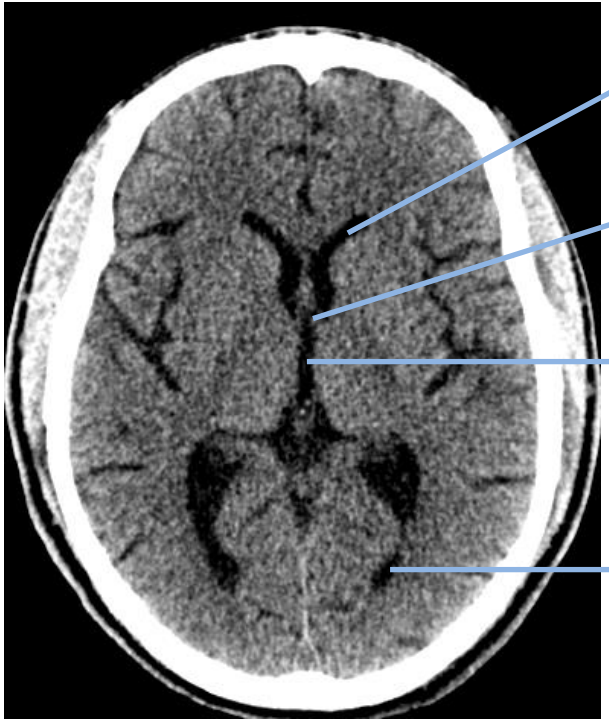
- Network of ependymal-lined CSF-filled spaces
  - Derivative of neural tube cavity
- 4 ventricles:
  - Paired lateral ventricles
  - 3rd ventricle
  - 4th ventricle



Anatomy: Lateral & 3rd Ventricles



Body, lateral ventricle



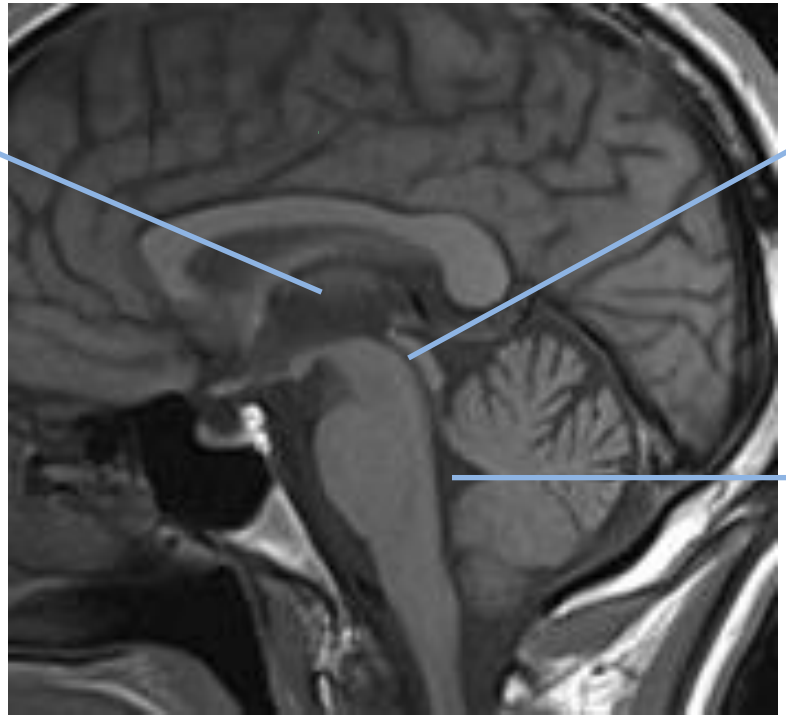
Frontal horn, lateral ventricle

Foramen of Monro

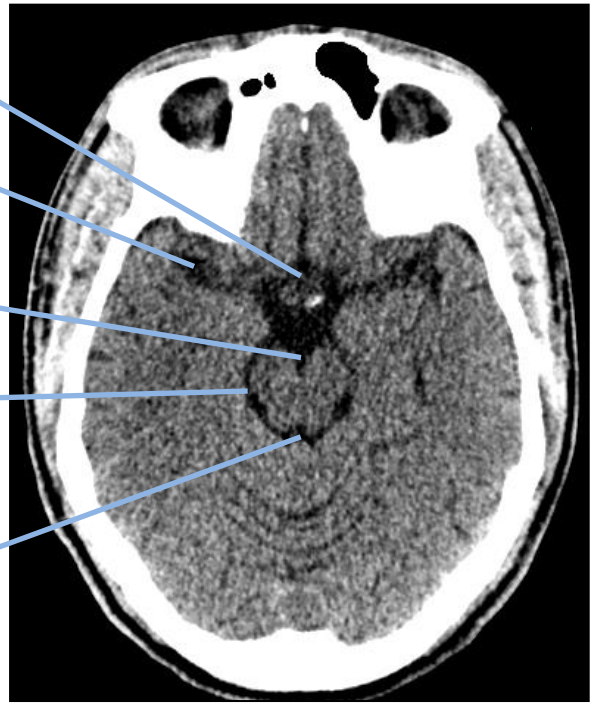
3rd ventricle

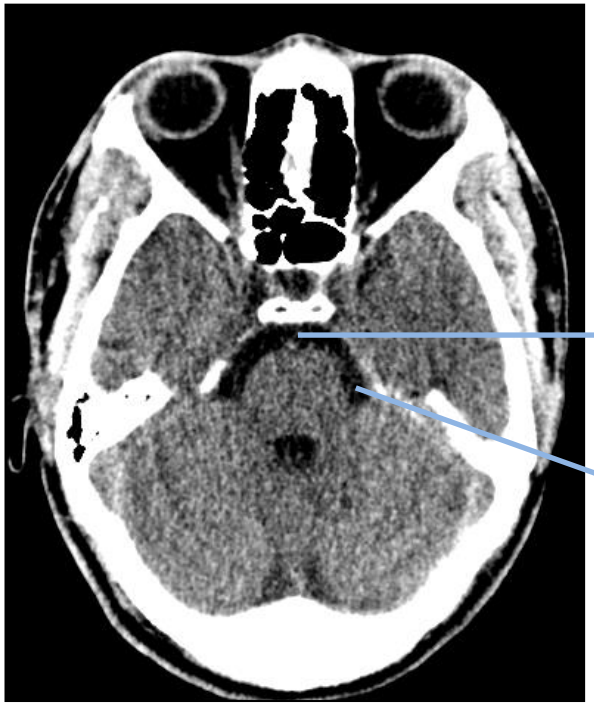
Occipital horn, lateral ventricle

Anatomy: 3rd and 4th Ventricles



Anatomy: Subarachnoid Cisterns





Suprasellar cistern

Sylvian fissure

Interpeduncular cistern

Ambient cistern

Quadrigeminal plate cistern

Prepontine cistern

CP angle cistern

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Emergency Head CT Checklist

- Is there midline shift?
- Is brain symmetry preserved?
- Are the cisterns patent (smile and pentagon)?
- Is the 4th ventricle patent and symmetric?
- Are the ventricles enlarged with sulcal effacement?

Mnemonic: Blood Can Be Very Bad

- Blood: intra- or extra-axial
- Cisterns and sulci: effacement or asymmetry
- Brain parenchyma: gray/white differentiation, symmetry, shift, density
- Ventricles: too large or too small
- Bones: skull fx, sinuses, mastoids, extracranial soft tissues

Blood
Cisterns
Brain
Ventricles
Bones

Module Outline

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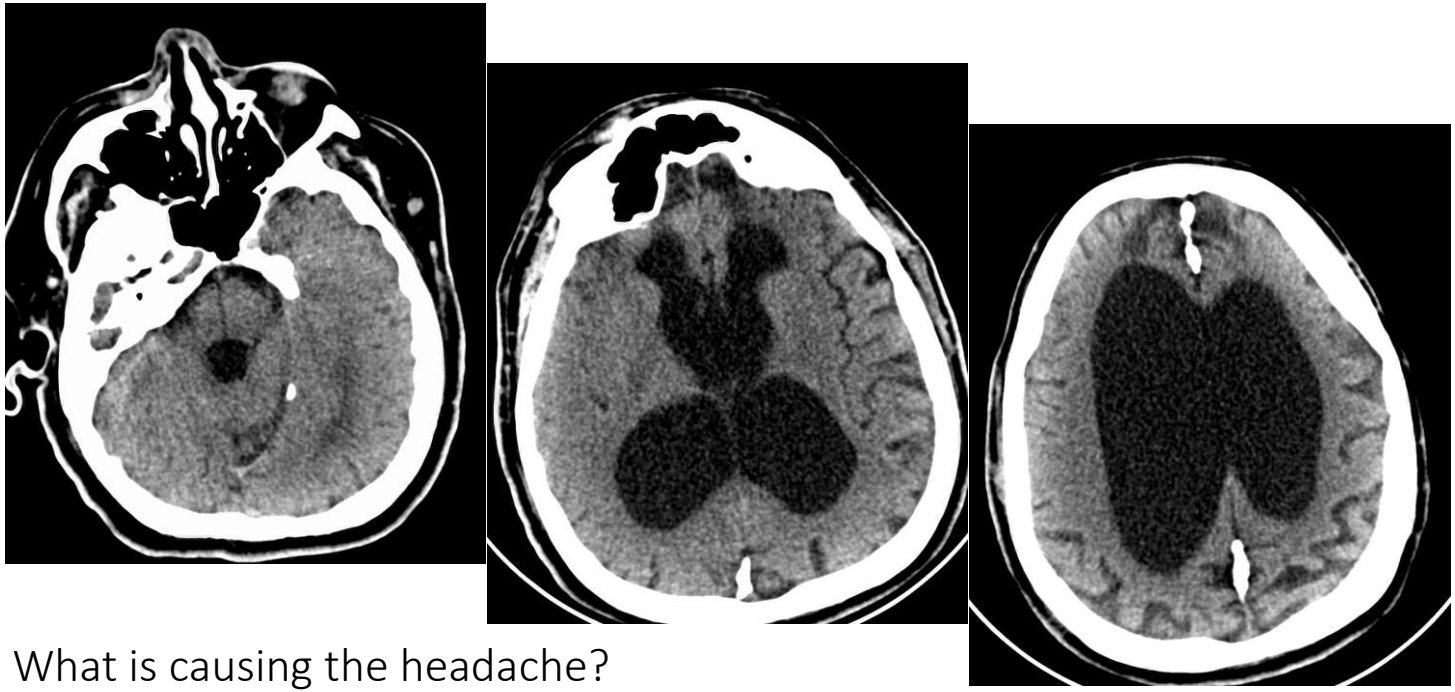
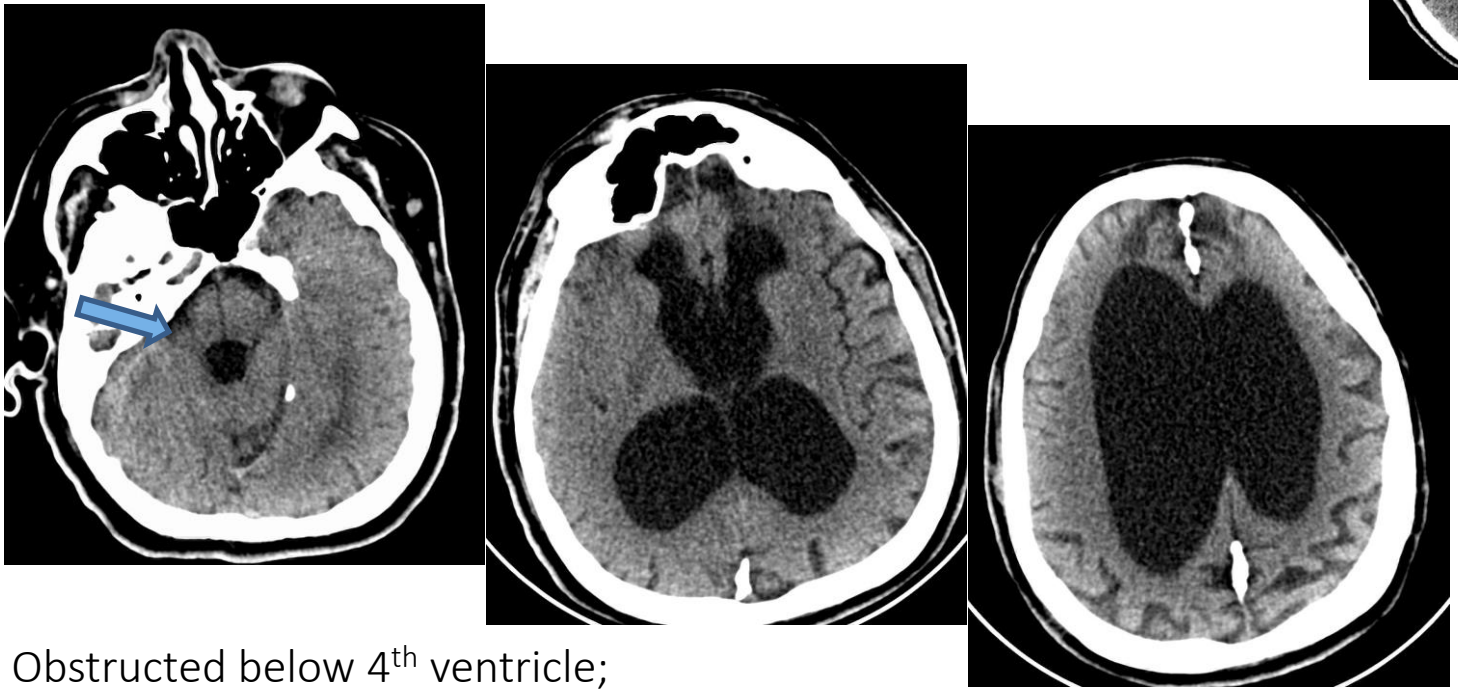
Case 1: Headache



What is causing the headache?

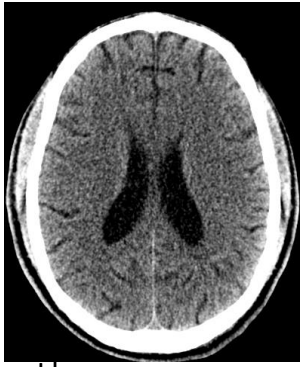
Case 1: Headache caused by hydrocephalus



Obstructed below 4th ventricle;
all ventricles are dilated!

Cases 2 & 3: Closed Head Injury

Case 2: Subdural Hemorrhage



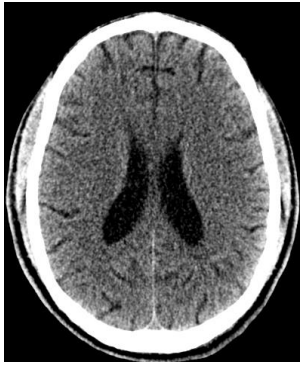
- Subdural hemorrhage (SDH) collects in the potential space between the inner dura and the arachnoid layer
- Results from bridging vein tears in MVAs, falls
- On CT: crescentic shape, hyperdense when acute, then isodense to hypodense when subacute and chronic
- Mass effect -> altered mental status

Case 2: Subdural Hemorrhage

- Subdural hemorrhage CT checklist:
  - Midline shift
  - Loss of symmetry
  - Cisternal effacement
- Subfalcine and uncal herniation

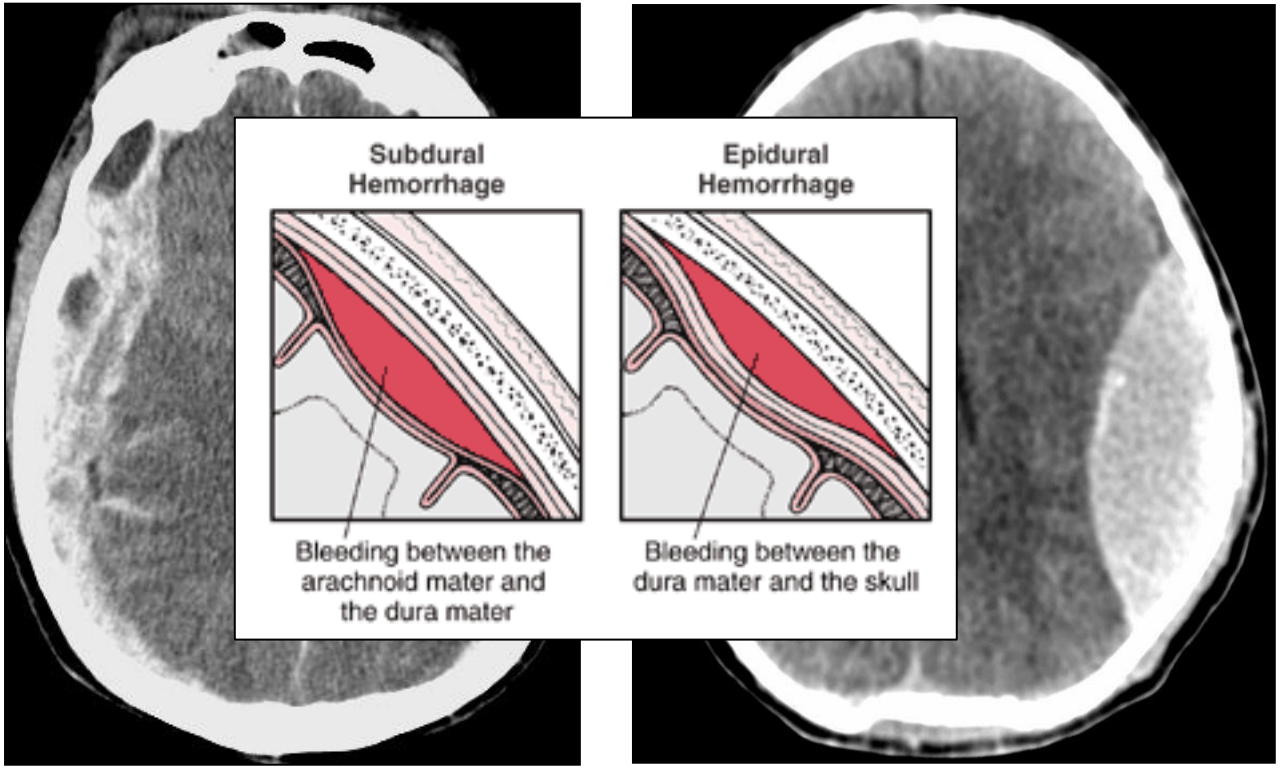
  →Neuro-ICU!

Case 3: Epidural Hemorrhage

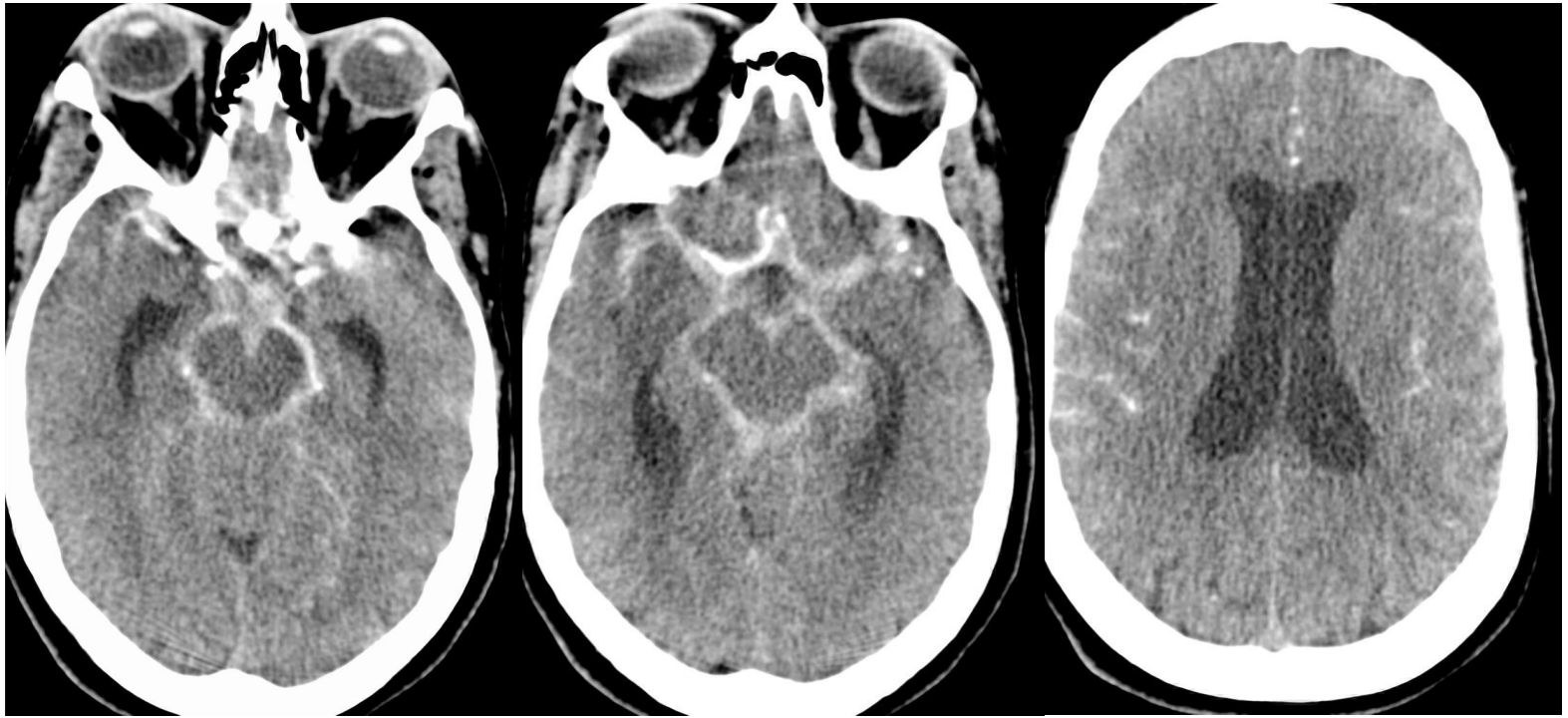


- Epidural hemorrhage forms between inner table of calvarium and outer layer of dura
- Results from middle meningeal artery tear
- >90% are associated with skull fx, usually in temporoparietal bones; can also be in frontal and parieto-occipital regions
- On CT: hyperdense biconvex lens shape
- Mass effect -> altered mental status
- Early identification critical to guide evacuation vs. early re-evaluation

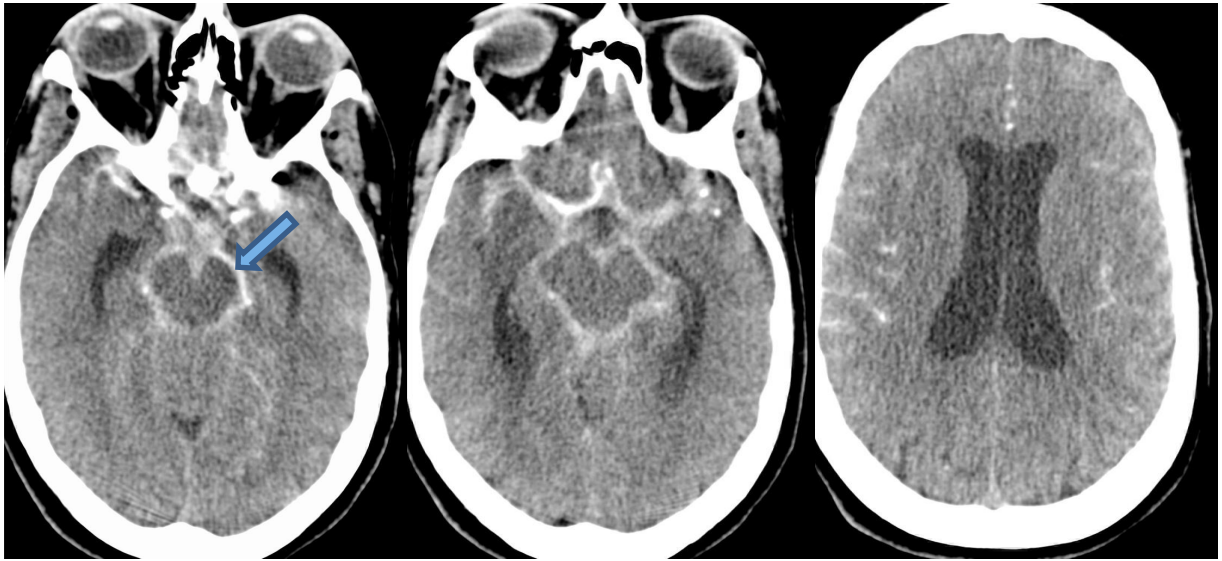
Cases 2 & 3: Closed Head Injury



Case 4: Worst Headache of Her Life

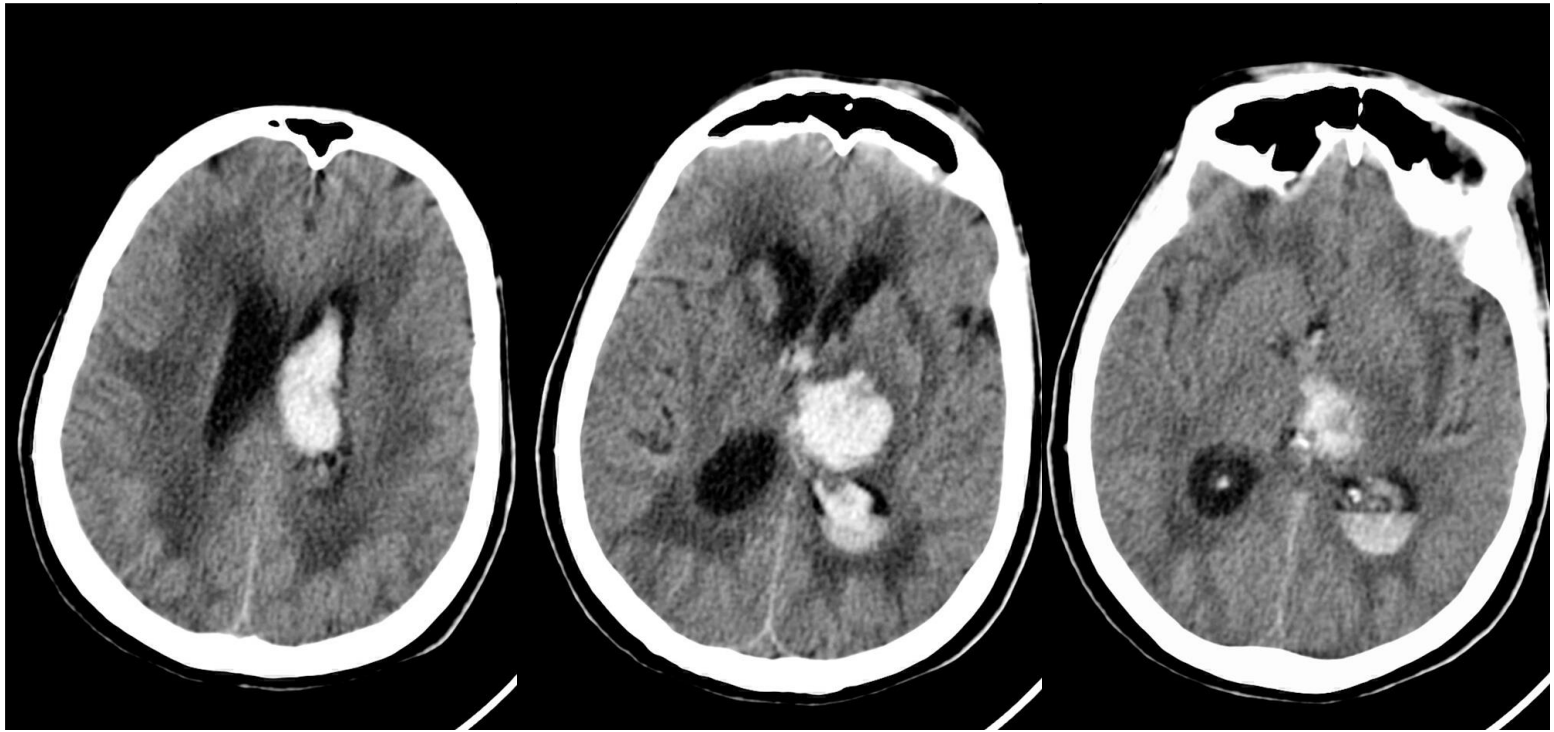


Case 4: Subarachnoid Hemorrhage

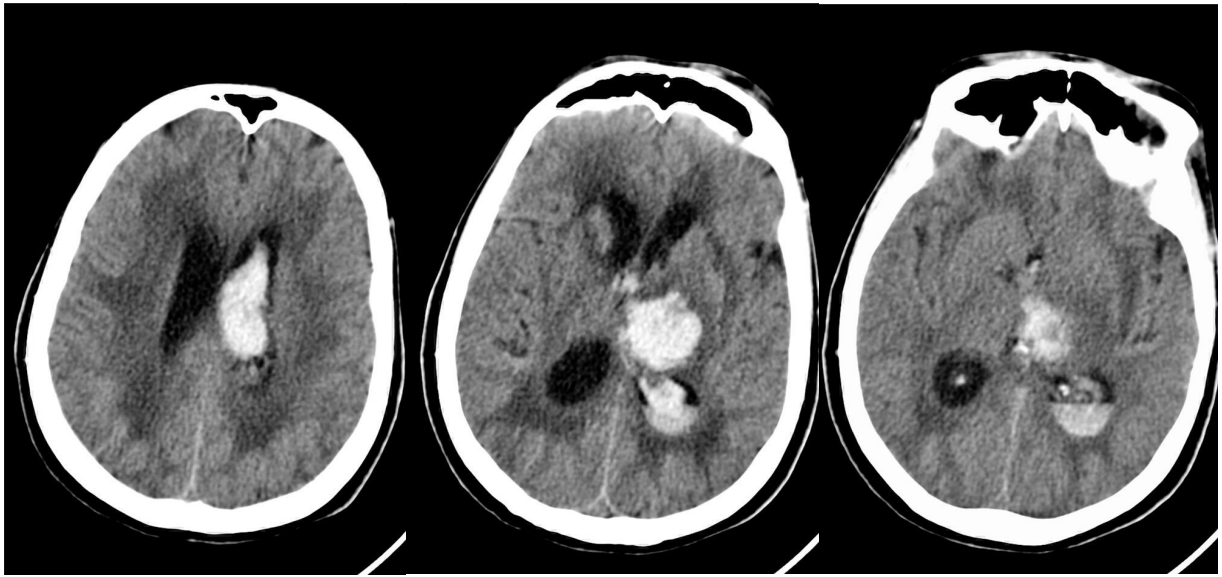


- Subarachnoid hemorrhage collects in the space between the pia and the arachnoid membrane
- Think trauma, aneurysm, HTN, AVM
- On CT: hyperdensity outlining the sulci and basilar cisterns, usually does not cause mass effect or edema

Case 5: Malignant Hypertension



Case 5: Intracerebral Hemorrhage



- Intracerebral hemorrhage occurs in the brain tissue and/or ventricles
- Biggest risk factors: HTN, amyloidosis
  - Typical locations of hypertensive hemorrhage: basal ganglia, thalamus, pons, cerebellar hemisphere
- On CT: hyperdense when acute

Head CT Recap

- Noncontrast head CT indications: trauma, stroke, hemorrhage, hydrocephalus
- CT windows: brain, SDH, stroke, bone
- Emergency checklist: shift, symmetry, cisterns, 4th ventricle, hydrocephalus
- Interpretation mnemonic: Blood Can Be Very Bad
- Emergency findings: hydrocephalus, subdural, epidural, subarachnoid, and intracerebral hemorrhage

References

- Birchard KR, Busireddy KR, Semelka RC. Critical Observations in Radiology for Medical Students. John Wiley & Sons; 2015.
- Epidural and subdural hemorrhage. Available at: http://casemed.case.edu/clerkships/neurology/neurlrngobjectives/epidural%20and%20subdural.htm. Accessed March 27, 2019.
- Mccollough CH, Bushberg JT, Fletcher JG, Eckel LJ. Answers to Common Questions About the Use and Safety of CT Scans. Mayo Clin Proc. 2015;90(10):1380-92.
- Runge VM, Smoker W, Valavanis A. Neuroradiology, The Essentials with MR and CT. Thieme Medical Pub; 2014.
- Ventricular system. Available at: https://en.wikipedia.org/wiki/Ventricular_system#/media/File:Blausen_0896_Ventricles_Brain.png. Accessed March 27, 2019.